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(54) **HEAD-MOUNTABLE ELECTRONIC DEVICE**

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(57) **ABSTRACT**

A securement arm of an optical device can include a first portion and a second portion. The first portion can include a first housing defining a first internal volume and a first aperture and an electronic component disposed in the internal volume and positioned to fluidly communicate with an external environment through the first aperture. The second portion can be removably connected to the first portion and include a second housing defining a second internal volume and a second aperture and a securement mechanism. The second housing can receive the first housing into the second internal volume.

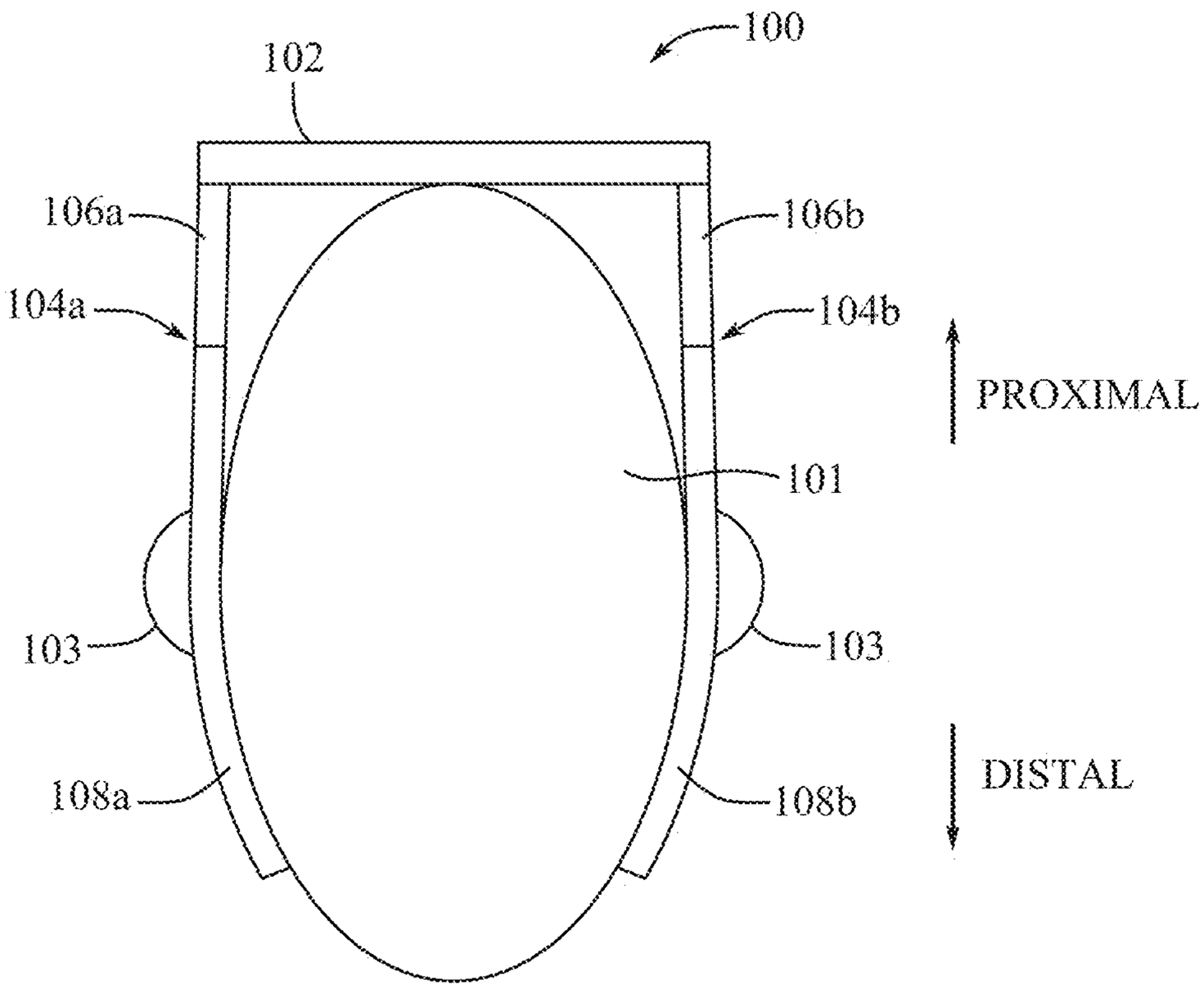
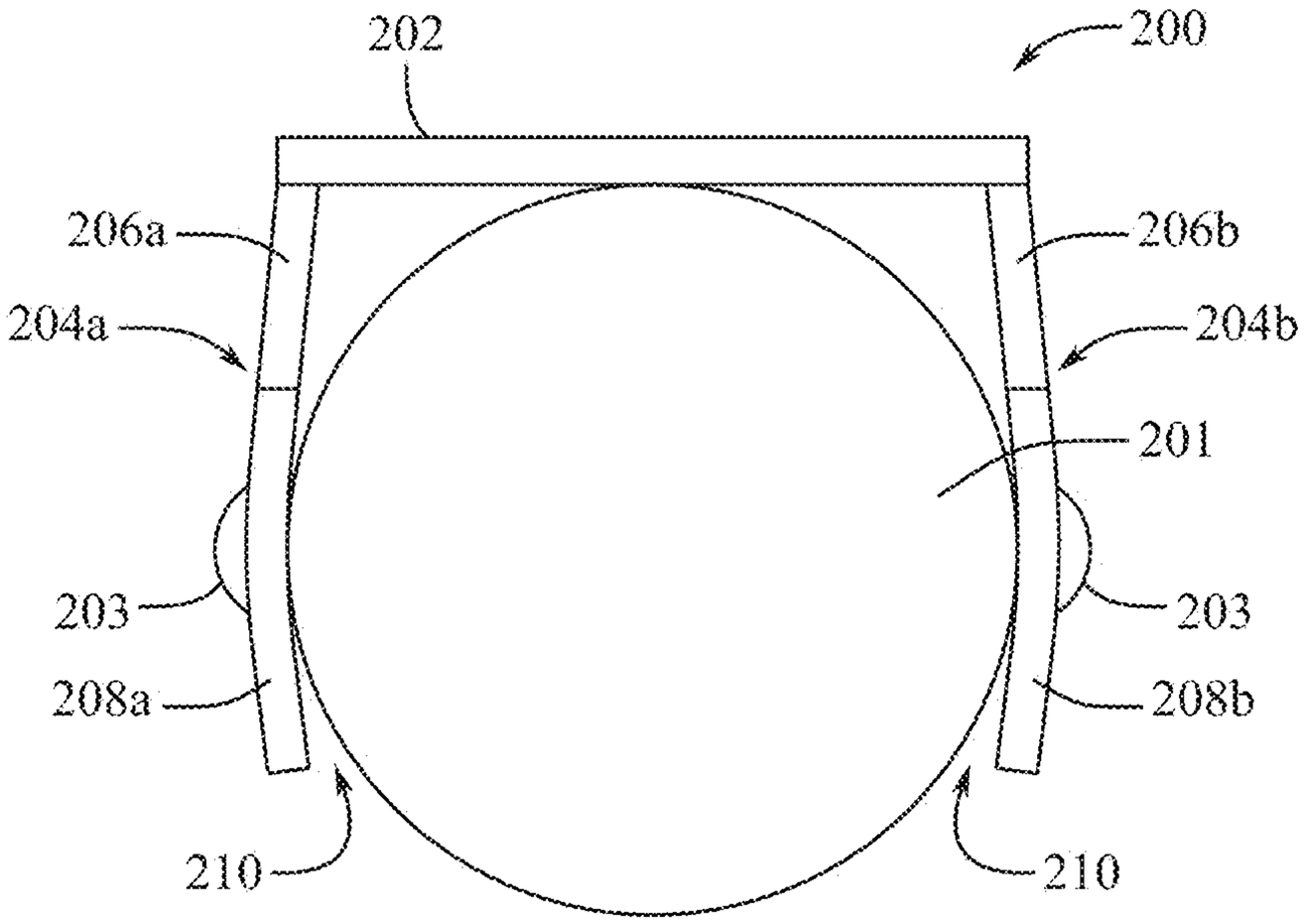

100
102
106a
106b
104a
104b
PROXIMAL
101
103
103
DISTAL
108a
108b

FIG. 1


202
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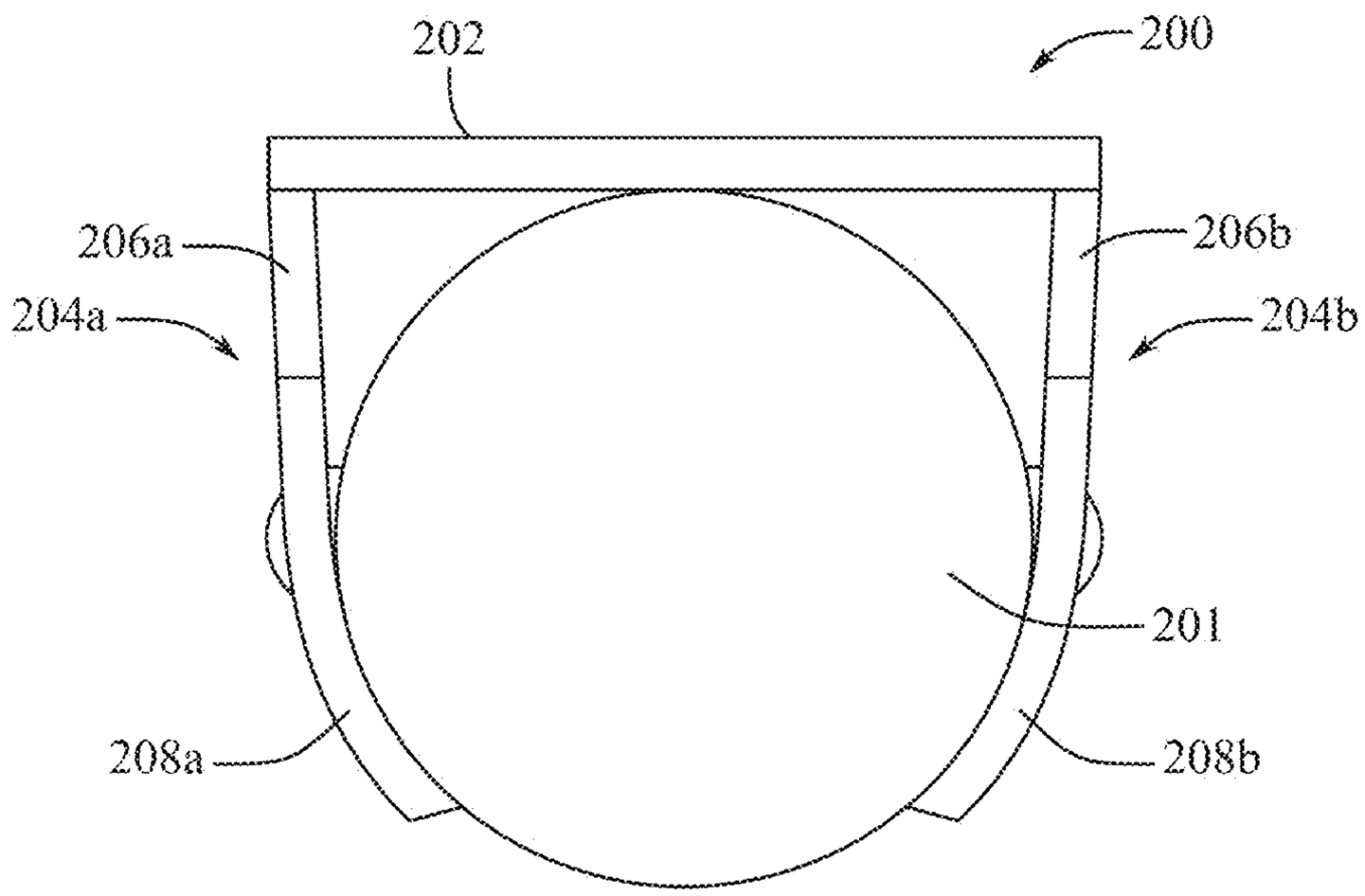
206a
206b
204a
204b
201
203
203
208a
208b
210
210

FIG. 2A


202
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206a
206b
204a
204b
201
208a
208b

FIG. 2B

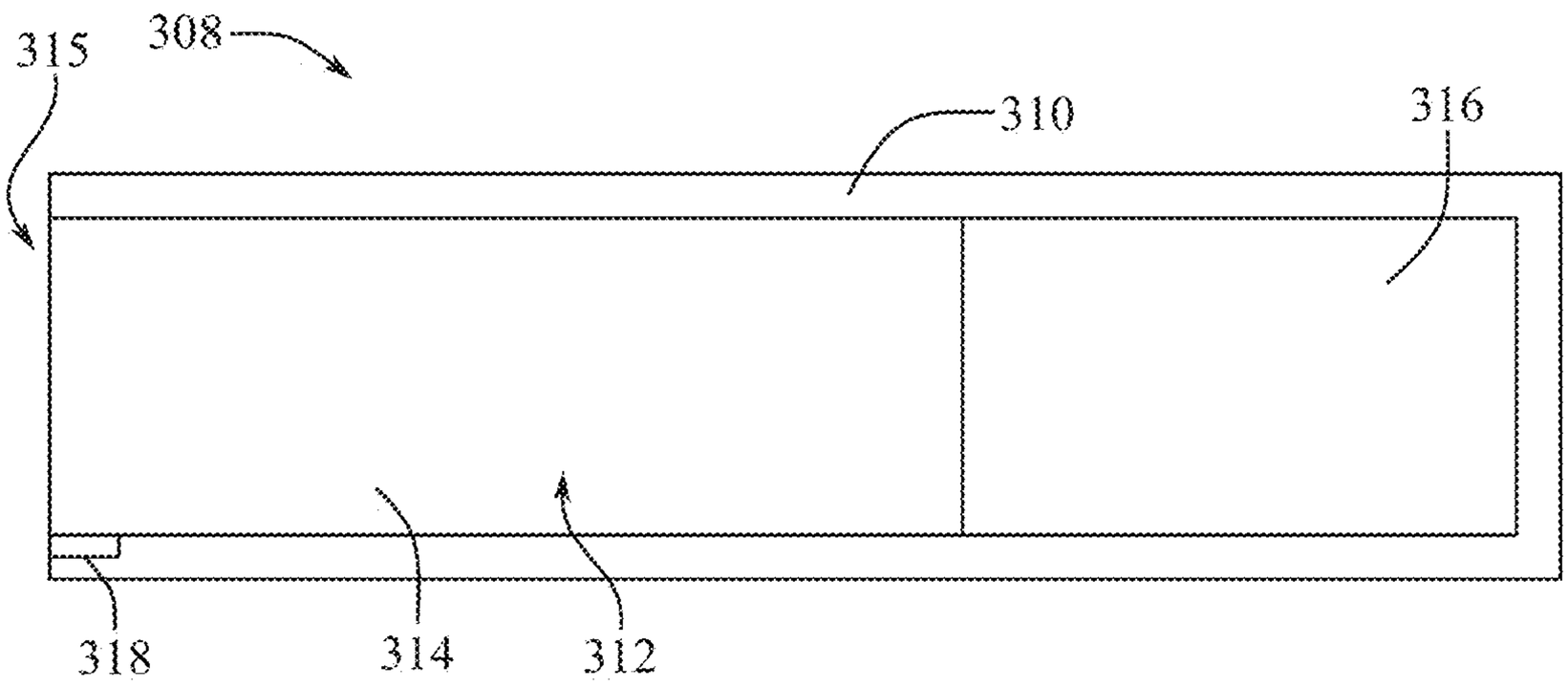
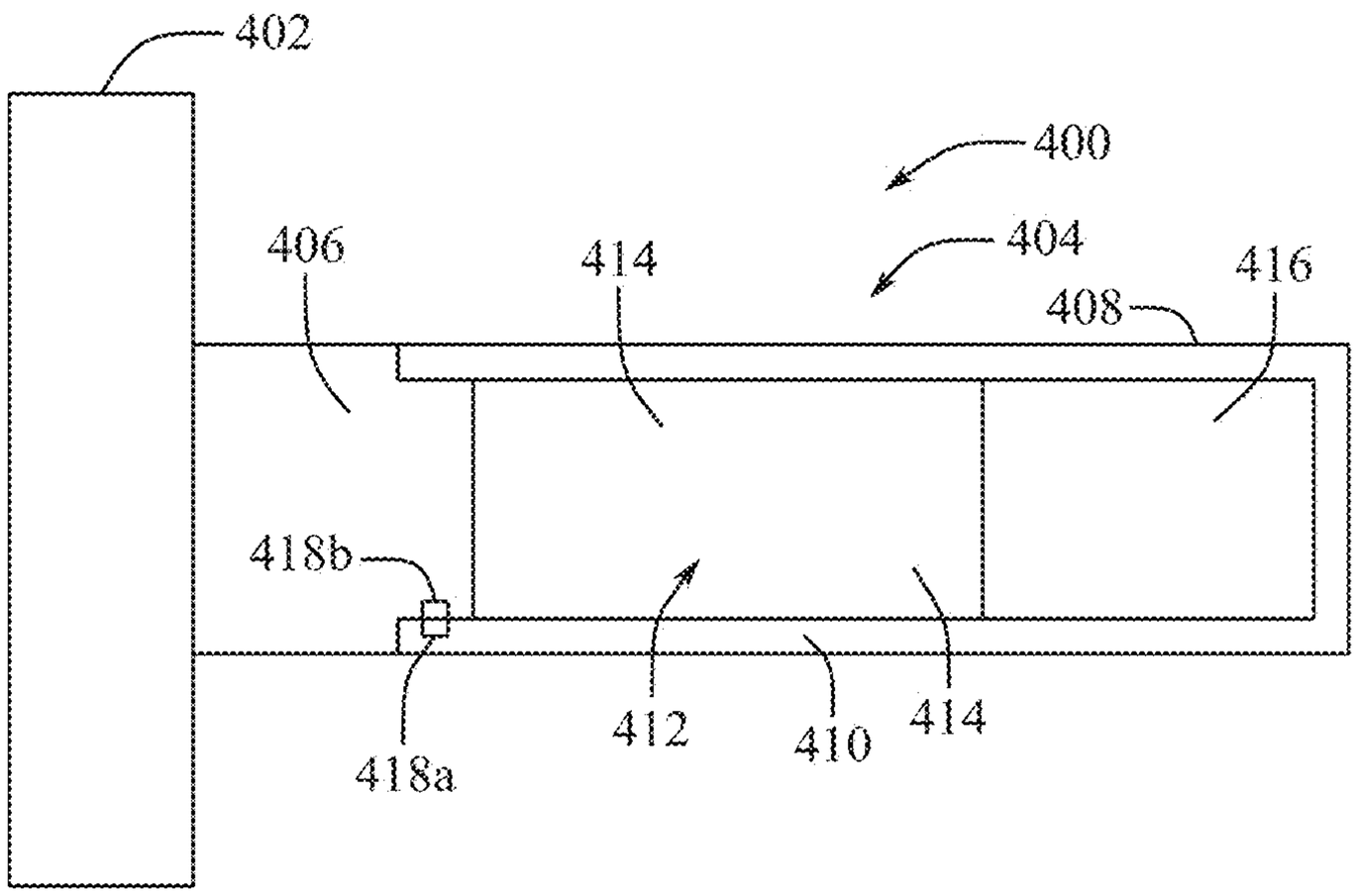


FIG. 3


402
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406
414
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416
408
418b
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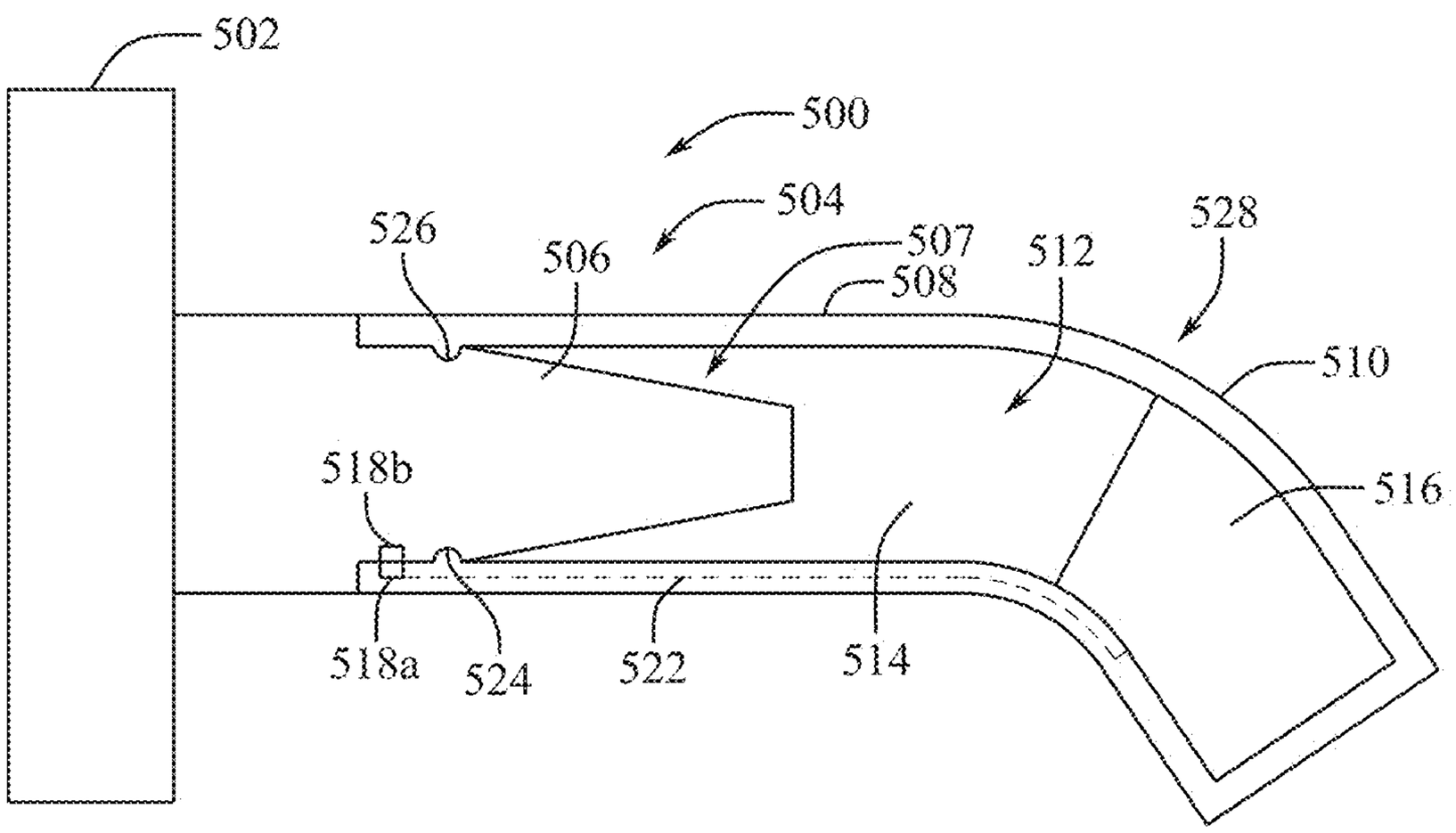
418a

FIG. 4


502
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504
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506
507
512
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518b
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518a
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522
514

FIG. 5

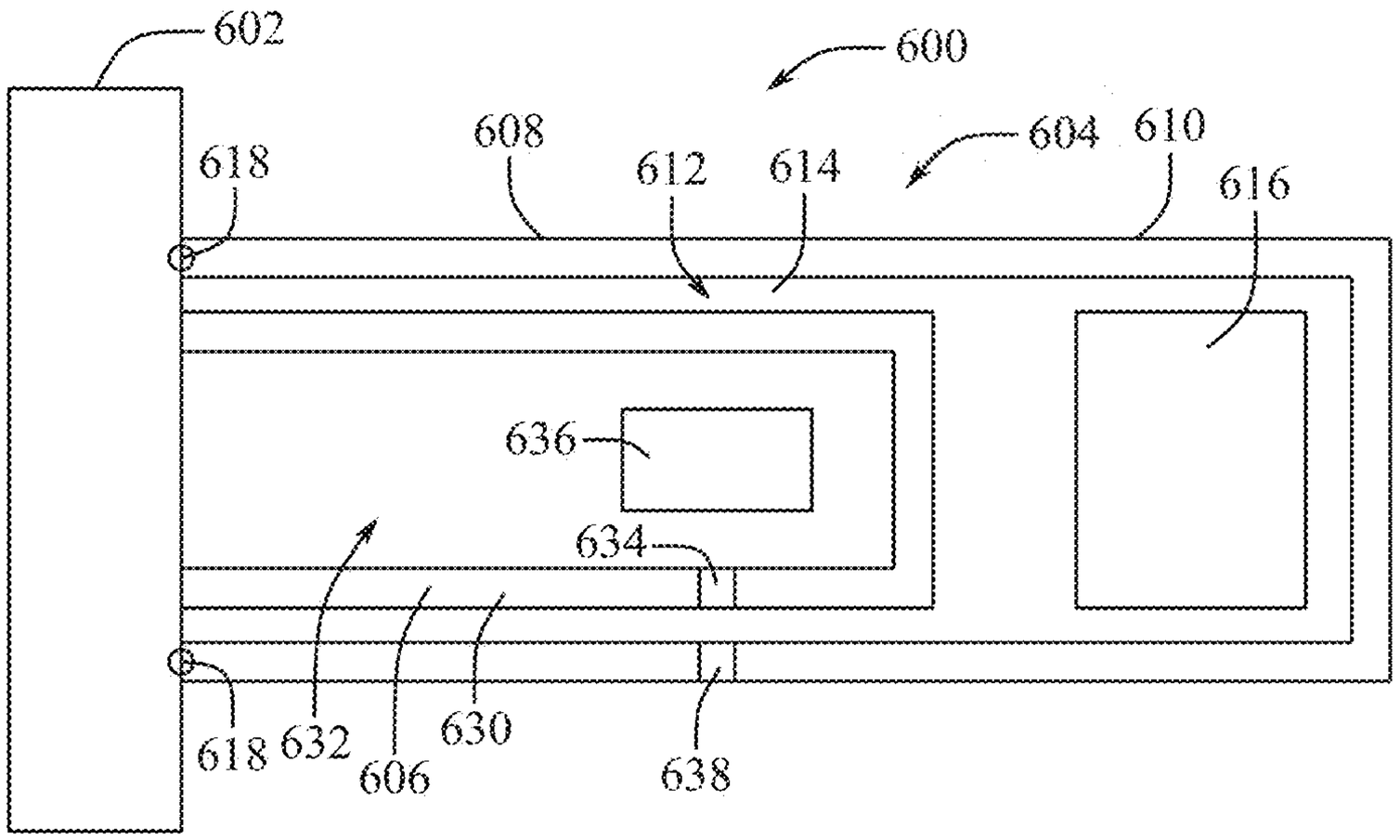
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FIG. 6

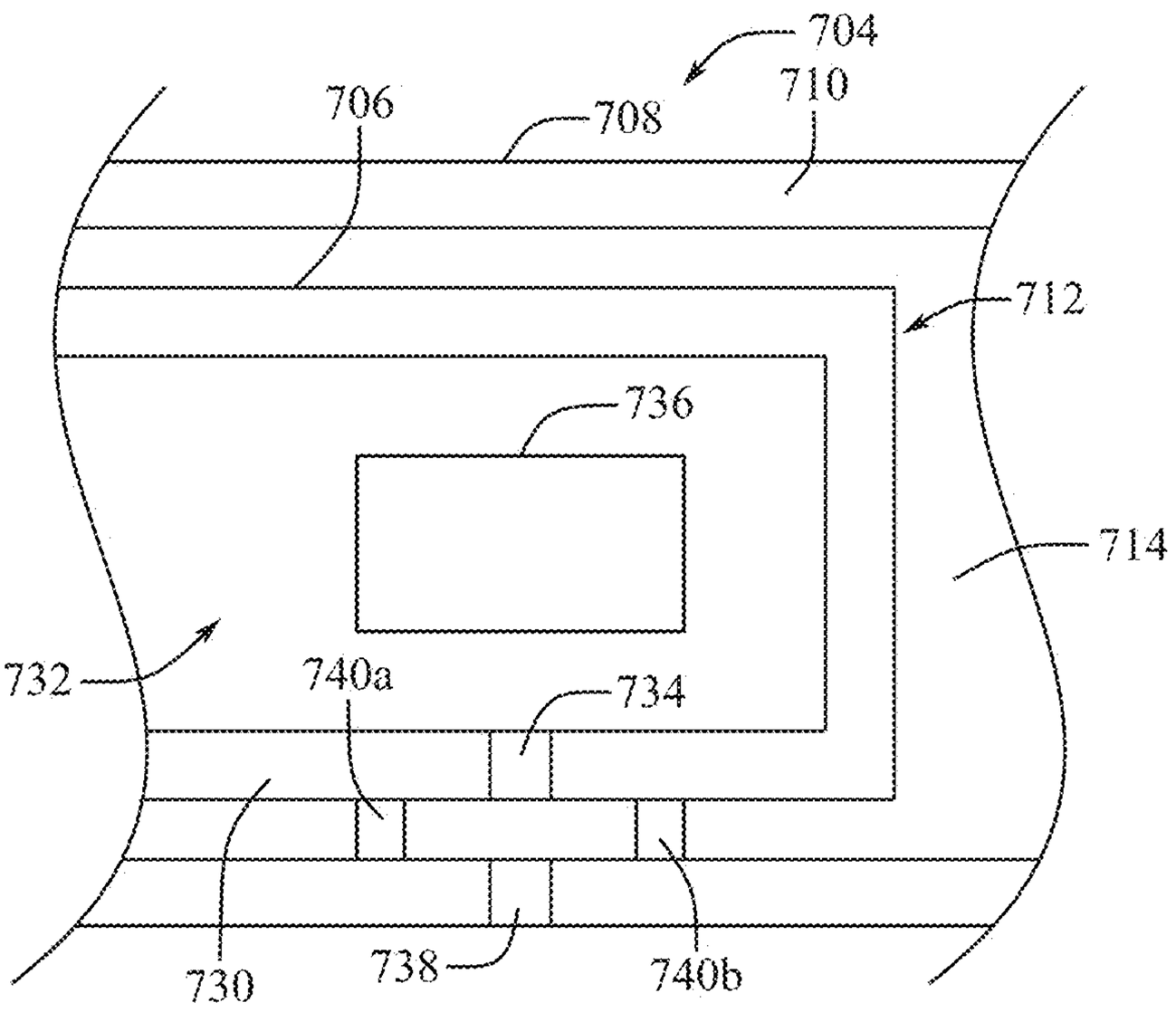
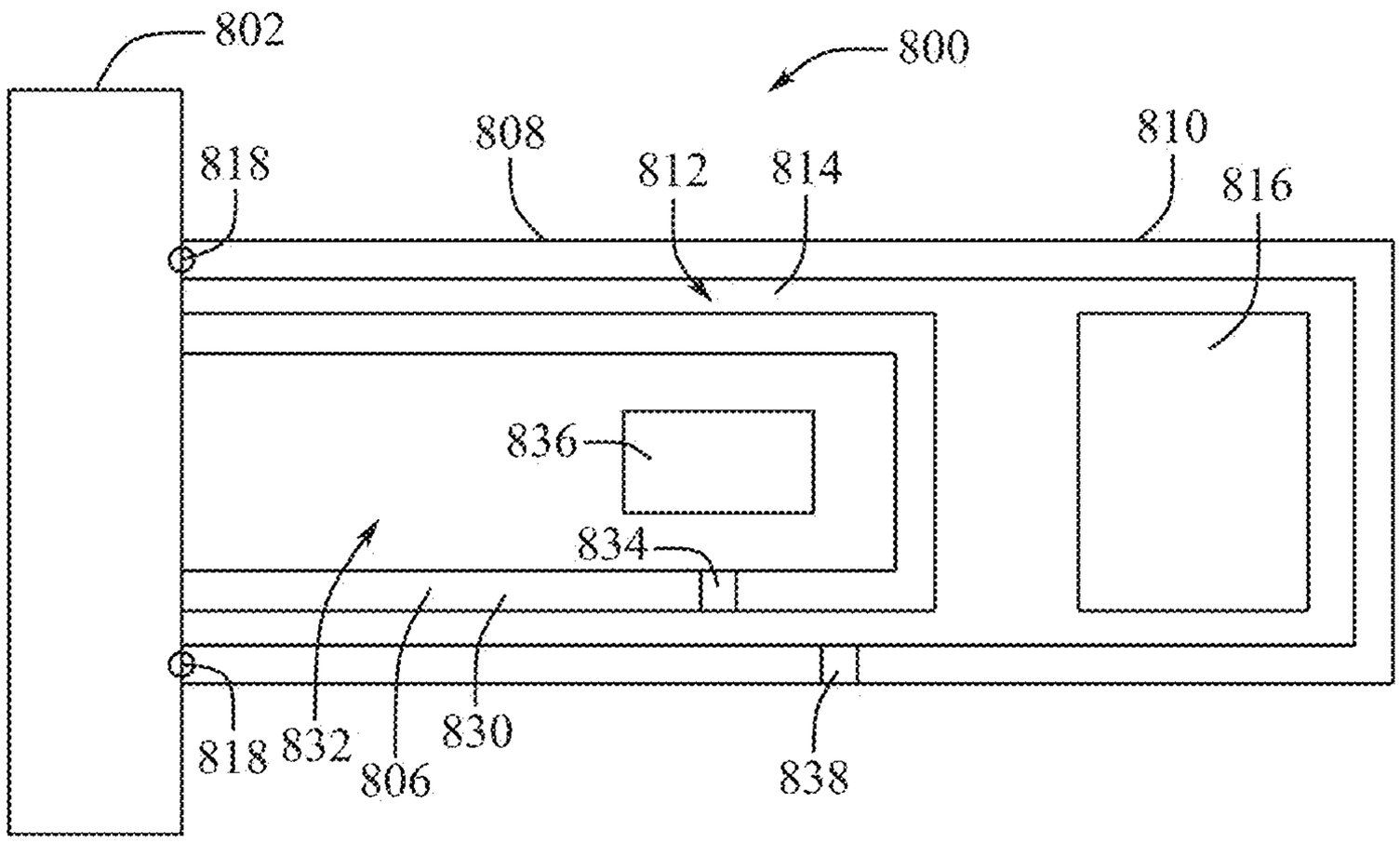

704
706
708
710
712
736
714
732
740a
734
730
738
740b

FIG. 7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800
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818
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836
834
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832
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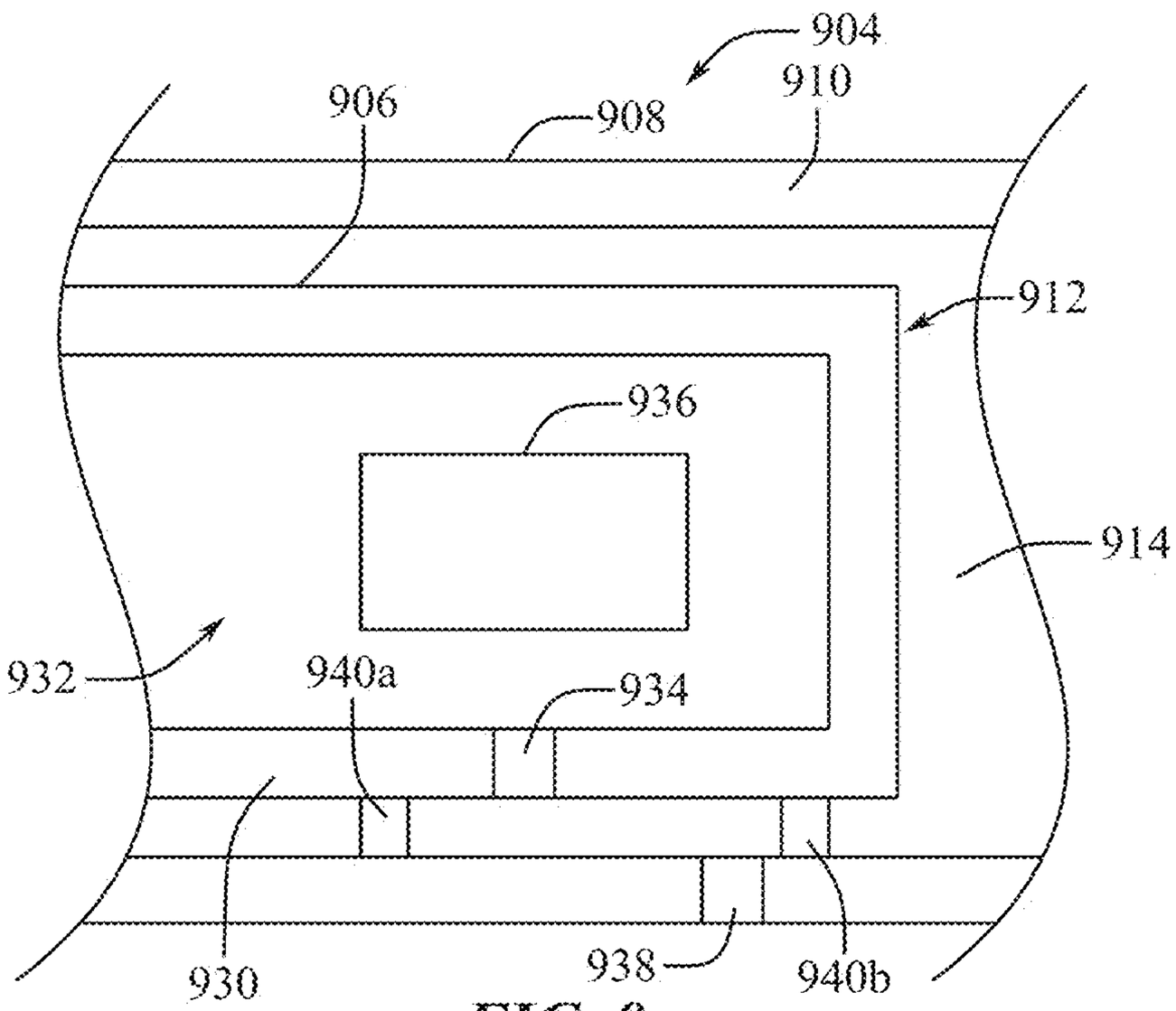
838

FIG. 8


904
906
908
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912
936
914
932
940a
934
930
938
940b

FIG. 9

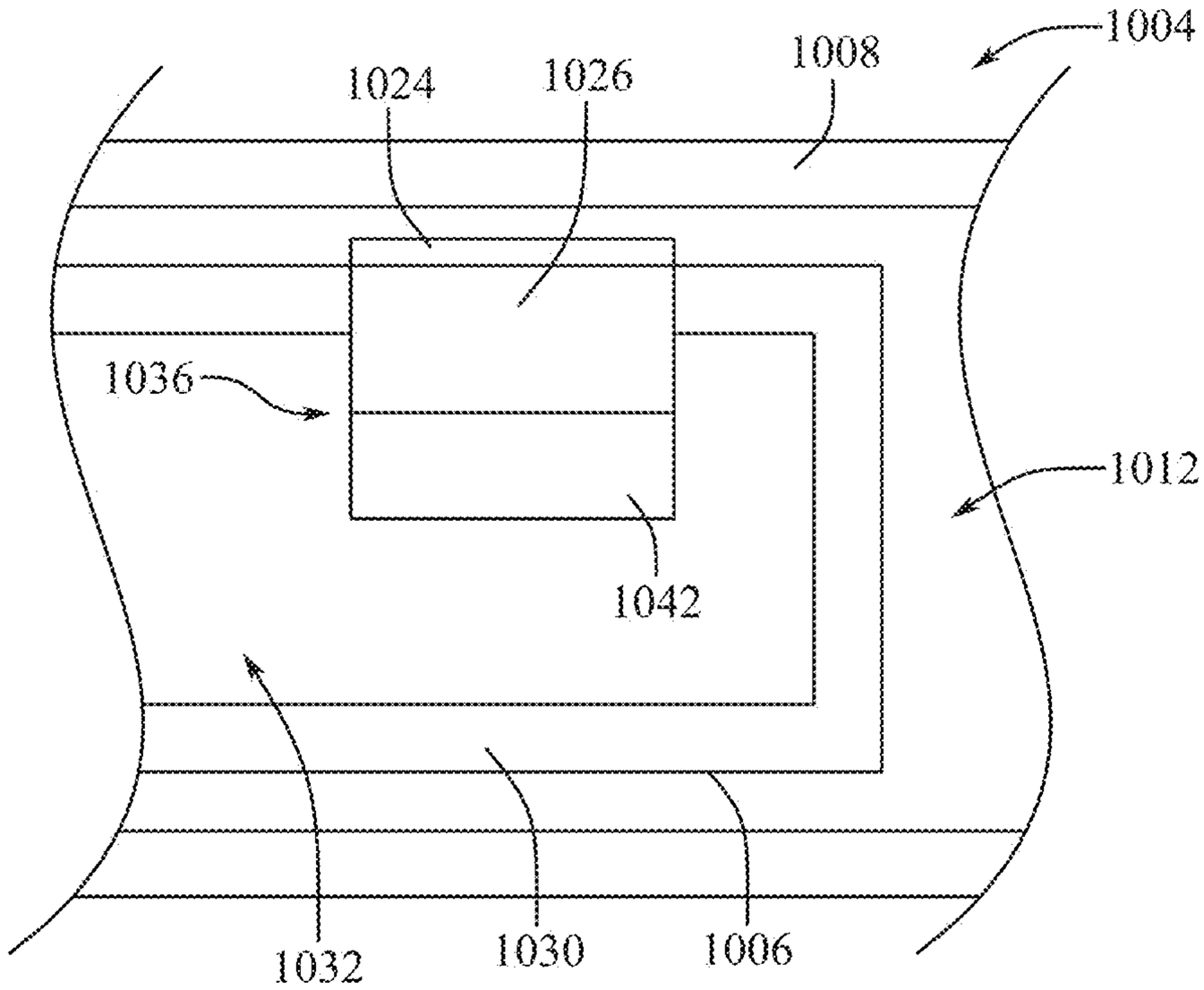

FIG. 10A

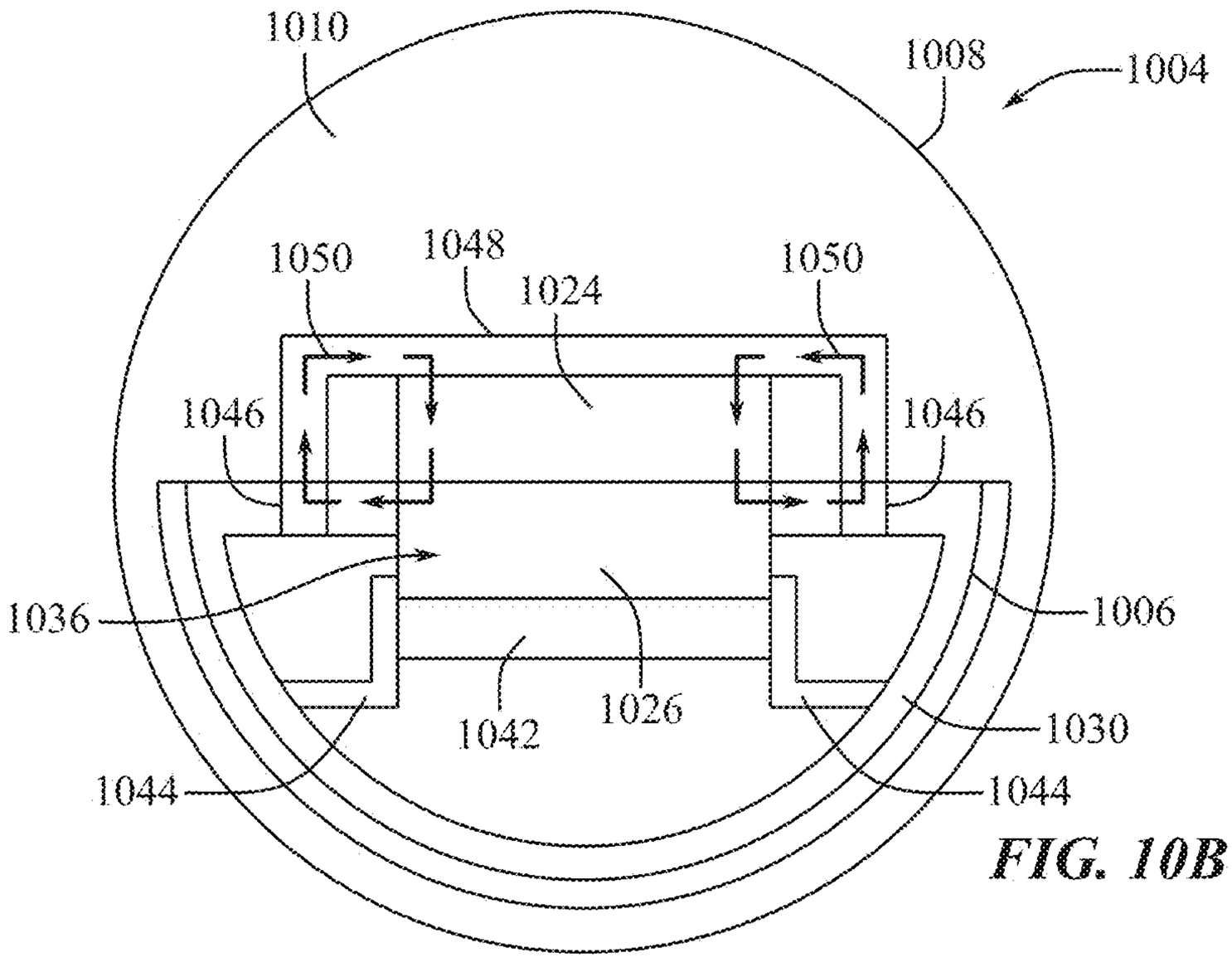

FIG. 10B

HEAD-MOUNTABLE ELECTRONIC DEVICE

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application is a national stage filing based off of PCT Application No. PCT/US2023/016618, filed Mar. 28, 2023, entitled "HEAD-MOUNTABLE ELECTRONIC DEVICE" and claims priority to U.S. Provisional Patent Application No. 63/362,310, filed 31 Mar. 2022, entitled "HEAD-MOUNTABLE ELECTRONIC DEVICE," the entire disclosures of which are hereby incorporated by reference.

FIELD

[0002] The described embodiments relate generally to electronic devices. More particularly, the present disclosure relates to head-mountable electronic devices.

BACKGROUND

[0003] Recent advances in portable computing have enabled head-mountable devices that provide augmented and virtual reality experiences to users. Various component of these devices, such as display screens, viewing frames, securement arms, speakers, batteries, and other components, operate together to provide an immersive and comfortable experience. However, the anatomy of each user's head is unique. One user's head can be larger than another or one head can be a different shape. Other anatomical features, including relative positions of a user's nose, forehead, and ears, can vary widely between users as well. The anatomical variety of heads presents a challenge for head-mountable devices designed for comfort and reliability.

[0004] In some head-mountable devices, for example, securement arms that extend along, or make contact with, opposing sides of a user's head can be used to secure the device to the user's head. However, the dimensions, angles, shape, and other physical characteristics of the arms that may be sufficient to comfortably and reliably secure the device to one user's head may not be sufficient to comfortably and reliably secure the device to another user's head.

[0005] Additionally, head-mountable devices can be used in a variety of different settings and during a variety of different activities. These can range from lying down still in bed to mountain biking or hiking outdoors. Thus, even for a single user, the securement arms of a head-mountable device that are comfortable and sufficient for securing the device during one activity may not be comfortable or sufficient for another activity.

[0006] Furthermore, head-mountable devices, as noted above, can include a number of electronic components configured to operate together to produce an altered or virtual reality experience to the user. Users often desire light weight, compact devices that are comfortable, portable, long lasting, and easily handled. Thus, the physical configuration of these electronic components, including batteries, speakers, processors, and so forth, affects the quality of the user's experience.

[0007] Accordingly, what is needed in the art are head-mountable devices and systems providing users having a wide variety of anatomical features and who participate in a wide variety of activities with comfortable and reliable components.

SUMMARY

[0008] In at least one example of the present disclosure, a removable securement arm of an optical device can include a housing defining an internal volume having an open proximal cavity, an electronic component disposed in the internal volume distal to the open proximal cavity, and an electrical connector disposed on the housing.

[0009] In one example, the electronic component can include a battery. In one example, the electronic component can be disposed in a distal portion defined by the housing. In one example, the electrical connector can be disposed at a proximal end of the housing. In one example, the removable securement arm can include a circuitry component connecting the electrical connector to the electrical component. In one example, a proximal end of the removable securement arm is open. In one example, the housing defines an aperture distal to the open proximal end.

[0010] In at least one example of the present disclosure, a securement arm of an optical device can include a first portion and a second portion. The first portion can include a first housing defining a first internal volume and a first aperture and an electronic component disposed in the internal volume and positioned to fluidly communicate with an external environment through the first aperture. The second portion can be removably connected to the first portion and include a second housing defining a second internal volume and a second aperture and a securement mechanism. In such an example, the second housing can receive the first housing into the second internal volume.

[0011] In one example, the securement mechanism can include a magnet. In one example, the electronic component can include a speaker. In one example, the magnet actuates the speaker. In one example, the speaker can direct sound out of the second aperture. In one example, a gap is formed between an external surface of the first housing and an internal surface of the second housing.

[0012] In at least one example of the present disclosure, a head-mountable display can include a viewing frame, a first arm portion, and a second arm portion removably secured to the first arm portion. The first arm portion can include a first housing extending from a proximal end to a distal end. The second arm portion can include a second housing defining a second internal volume having an open cavity. In such an example, the second arm portion contacts the first arm portion at the proximal end and the first housing is free-floating in the open cavity.

[0013] In one example, the first housing defines a first internal volume and a first electronic component is disposed in the first internal volume. In one example, the head-mountable display can further include a second electronic component disposed in the second internal volume. In one example, the second electronic component can include a battery. In one example, the first electronic component can include a speaker. In one example, the second arm portion can include a magnet. In one example, the magnet actuates the speaker.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The disclosure will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and in which:

[0015] FIG. **1** shows a top view of an example of a head-mountable electronic device worn by a user;

[0016] FIG. **2**A shows a top view of an example of a head-mountable electronic device worn by a user;

[0017] FIG. **2**B shows a top view of an example of a head-mountable electronic device worn by a user;

[0018] FIG. **3** shows a side view of an example of a removable securement arm;

[0019] FIG. **4** shows a side view of an example of a head-mountable electronic device with a removable securement arm;

[0020] FIG. **5** shows a side view of an example of a head-mountable electronic device with a removable securement arm;

[0021] FIG. **6** shows a side view of an example of a head-mountable electronic device with a removable securement arm;

[0022] FIG. **7** shows a partial cross-sectional view of an example of a securement arm of a head-mountable electronic device;

[0023] FIG. **8** shows a side view of an example of a head-mountable electronic device with a removable securement arm;

[0024] FIG. **9** shows a partial cross-sectional view of an example of a securement arm of a head-mountable electronic device;

[0025] FIG. **10**A shows a partial cross-sectional view of an example of a securement arm of a head-mountable electronic device; and

[0026] FIG. **10**B shows a cross-sectional view thereof.

DETAILED DESCRIPTION

[0027] Reference will now be made in detail to representative embodiments illustrated in the accompanying drawings. It should be understood that the following descriptions are not intended to limit the embodiments to one preferred embodiment. To the contrary, it is intended to cover alternatives, modifications, and equivalents as can be included within the spirit and scope of the described embodiments as defined by the appended claims.

[0028] The following disclosure relates to electronic devices. More particularly, the present disclosure relates to head-mountable electronic devices. In at least one example, a head-mountable device can include a viewing frame and a securement arm extending from the viewing frame. Examples of head-mountable electronic devices can include virtual reality or augmented reality devices that include an optical component. In the case of augmented reality devices, optical eyeglasses can be worn on the head of a user such that optical lenses and/or optical displays are positioned in front of the user's eyes. In another example, a virtual reality device can be worn on the head of a user such that a display screen is positioned in front of the user's eyes. The viewing frame can include a housing or other structural component supporting or housing the optical component, for example lenses or screens.

[0029] Examples of the present disclosure can include a securement arm extending from the viewing frame, which can be fixed in position relative to the viewing frame or rotatably secured thereto. An optical electronic device can include two opposing securement arms that can apply pressure to or around a user's head to maintain the viewing frame resting on the user's nose and/or cheeks. In some examples, the securement arms can rest on top of the user's ears to assist in securing the head-mountable optical device to the head of the user.

[0030] The securement arm can include multiple portions and one or more electronic components used to operate the head-mountable electronic device. These electronic components can include any components used by the head-mountable electronic device to produce a virtual or augmented reality experience. For example, electronic components of the securement arm can include one or more speakers, processors, batteries, circuitry components including wires and circuit boards, or any other electronic components used in the head-mountable device to deliver augmented or virtual reality visuals, sounds, and other outputs. Disposing various electronic components within the securement arm reduces weight and space needed for the viewing frame and lenses and/or display screens of the device. This redistributed weight can relieve pressure of sensitive features like the user's nose and cheeks to create a more comfortable experience. This weight distribution can also be used to balance weight from the front of the device (at the viewing frame) to the back of the device (at the distal ends of the securement arms), resulting in a more secure and comfortable experience.

[0031] In examples where the securement arm includes multiple portions, a first arm portion can extend from the viewing frame and include a first housing extending from a proximal end to a distal end. A second portion of the arm can be removably secured to the first arm portion, with the second arm portion including a second housing defining a second internal volume having an open cavity. In such examples, various electronic components can be disposed in the first and second housings of the arm portions and be electrically connected when the first and second portions are secured together. The second portion having the open cavity can include an electrical connector that completes an electrical circuit to electrically connect the electronic components disposed in the first and second portions.

[0032] For example, the a battery can be disposed in the second portion so that when the first portion and the second portion are connected, the battery delivers power to electronic components of the first portion and/or components in the viewing frame, such as display components. The first portion of the securement arm can include any number of components powered by the battery of the second portion of the securement arm, including processors, speakers, logic boards and other circuit elements, sensors, and so forth.

[0033] Head-mountable electronic devices, such as head-mountable optical devices delivering virtual and augmented reality experiences, can be used in a variety of different settings and during a variety of activities. For example, a user may lie down on a sofa or a bed while watching a movie or playing a game with a head-mountable virtual reality device. That same device, or some other augmented reality device, such as electronic glasses, can be used while exercising indoors on an exercise machine. Similarly, devices like augmented reality glasses can be used while being active outdoors, either while hiking, biking, or swimming. The devices of the present disclosure include components, such as securement arms, which can be adapted to effectively secure head-mountable devices to the user during any of the various activities in which the user participates.

[0034] In addition, the head measurements and anatomical features of each user vary such that a securement arm of the

same length, shape, and curvature, may not be appropriate for every user. For example, some heads are more round than others. Some heads are larger or smaller and the position of a user's nose relative to their eyes can vary. The position of a user's ears relative to their nose or forehead can vary from one user to another such that a set of securement arms that effectively secure a head-mountable device to one user may not effectively secure the same device to anther user.

[0035] In addition, manufacturing individualized arms for each unique customer can be burdensome and often economically unfeasible. Because the second portion of securement arms disclosed herein are removable from the first portions, a user can swap out the second portion with another portion having a fully charged battery or another portion with a shape and size that better fits his or her head. In examples of the present disclosure, different portions of the securement arms of head-mountable devices can be disconnected, reconnected, and otherwise swapped out to provide customized fits and long lasting power during use. The various portions can be connected in such a way that the head-mountable display continues to function seamlessly regardless of the swappable portions and the components in the securement arms are protected from wear and tear due to constant swapping and use.

[0036] For example, a first housing of the first portion of a securement arm can extend into an open, empty cavity of the internal volume of the second portion with a gap or empty space between the outer surface of the first housing and an inner surface of the second housing of the second portion. In this way, forces and strains acting on the second portion, whether due to connecting and disconnecting the portions or due to normal use of the device, do not transfer to the first housing and the electronic components disposed therein.

[0037] As noted above, the head-mountable electronic devices of the present disclosure include securement arms and components that can be manufactured to be used with different head anatomies and during various activities. The same user can swap out a portion of the securement arms of a device, for example, to pressure more tightly or wrap further around his or her head when using the head-mountable device for exercise or other active scenarios. The same user can swap out a portion of the securement arms again for a more comfortable fit while using the head-mountable device for less active scenarios, including lying down, sitting, or walking. In addition, some head-mountable devices may be used by multiple people, including multiple people in a household or business office, with each person having a different head geometry. Securement arms for devices described herein can be swapped out for the same device to be comfortably and effectively used by each of the multiple individuals using the device.

[0038] In addition, swapping out portions of the securement arms of a head-mountable device can lengthen operation of the device. A swappable portion, for example, can include a battery that powers the device such that swapping that portion out with a portion having a fully recharged battery allows the user to continue using the device while the battery of the removed portion recharges. If the user multiple portions to swap out in this way, the device can be used without running out of power at all.

[0039] In addition to the functional advantages described herein, the securement arms of the exemplary head-mountable devices described herein can offer unique opportunities for style customization to the user. Users can opt for securement arms of different colors and materials to differentiate the electronic device and make the device more personal to the user. The designs and aesthetic appearance of the securement arms can also be easily altered to accommodate different looks and preferences.

[0040] These and other embodiments are discussed below with reference to FIGS. **1**-**10**B. However, those skilled in the art will readily appreciate that the detailed description given herein with respect to these Figures is for explanatory purposes only and should not be construed as limiting. Furthermore, as used herein, a system, a method, an article, a component, a feature, or a sub-feature including at least one of a first option, a second option, or a third option should be understood as referring to a system, a method, an article, a component, a feature, or a sub-feature that can include one of each listed option (e.g., only one of the first option, only one of the second option, or only one of the third option), multiple of a single listed option (e.g., two or more of the first option), two options simultaneously (e.g., one of the first option and one of the second option), or combination thereof (e.g., two of the first option and one of the second option).

[0041] FIG. **1** illustrates a top view of an example of a head-mountable electronic device **100** worn on the head **101** of a user. The device **100** can include a viewing frame **102** configured to secure one or more optical lenses or display screens in front of the eyes of the user. The device **100** can also include one or more securement arms **104***a*, **104***b* secured to the viewing frame **102** and extending distally toward the rear of the user's head **101**. In the illustrated example, the securement arms **104***a*, **104***b* extend over the user's ears **103** and curve along with the user's head **101**. The securement arms **104***a*, **104***b* can apply opposing pressures to the sides of the user's head **101**, as shown, to secure the device **100** to the user's head **101**. The securement arms **104***a*, **104***b* can also rest on the user's ears **103** and secure the device **100** via friction between the securement arms **104***a*, **104***b* and the head **101**.

[0042] As noted, the securement arms **104***a*, **104***b* can also curve along with the curve of the user's head **101**. In particular, in at least one example, the securement arms **104***a*, **104***b* can include a first proximal portion **106***a*, **106***b* and a second distal portion **108***a*, **108***b*, respectively. The terms "proximal" and "distal" can be used to reference the position of various components of devices described herein relative to the viewing frame **102** of the device **100**. The orientation of the "proximal" and "distal" directions relative to devices described herein is shown in FIG. **1**.

[0043] The second portion **108***a*, **108***b* of each arm **104***a*, **104***b* can be curved or disposed at an angle relative to the first proximal portion **106***a*, **106***b* such that at least a portion of each arm **104***a*, **104***b* makes contact along a length of the side of the user's head. In the illustrated example of FIG. **1**, at least the second portions **108***a*, **108***b* of the arms **104***a*, **104***b* curve with the user's head **101** to make contact with the head **101**. In addition, the arms **104***a*, **104***b* can extend distally and curve around a portion of the back of user's head **101**, as shown, to hook around the head **101** and prevent the viewing frame **102** from being pulled forward proximally off the face/head **101** of the user.

[0044] However, as noted above, the head **101** of the user can be a unique shape and size with a unique position of each ear **103** such that the curvature of the arms **104***a*, **104***b* of the

device **100** shown in FIG. **1** may not be a match for the curvature and anatomy of the head of a different user. In general, the hooked arms **104***a*, **104***b* around the sides and rear of the head **101** in addition to the increased contact area and/or length between the arms **104***a*, **104***b* and head **101** improve the resistance of the arms **104***a*, **104***b* to forces pulling the viewing frame **102** proximally off the user's head **101**. Such forces can arise from jostling and bumping during normal use of the device **100** or more detrimentally during falls or contact with other objects during use. Thus, the curvature of the securement arms **104***a*, **104***b*, and more particularly the curvature of the second portions **108***a*, **108***b* of the arms **104***a*, **104***b*, which can be effective for retaining the device **100** on the head **101** shown in FIG. **1**, may not be effective for a user with a head of a different size or shape.

[0045] The second portions **108***a*, **108***b* of the securement arms **104***a*, **104***b* shown in the examples of FIG. **1** can be removably secured to the first portions **106***a*, **106***b* of the securement arms **104***a*, **104***b*. In this way, if the user desires a second portion **108***a*, **108***b* having a different size or curvature to better fit his or her head, the user can remove one or both of the second portions **108***a*, **108***b* from the first portions **106***a*, **106***b* and reconnect another more suitable second portion **108***a*, **108***b*. This can also be done in order to swap out a second portion **108***a*, **108***b* if the second portion **108***a*, **108***b* includes a battery that needs recharging so that another second portion **108***a*, **108***b* with a fully charged battery can be reconnected for further use of the device **100**. More details regarding the connection features, electronic components and electrical connectivity between the first and second portions **106***a*, **106***b*, **108***a*, **108***b* shown in FIG. **1** will be given in more detail in reference to other figures described below.

[0046] Any of the features, components, and/or parts, including the arrangements and configurations thereof shown in FIG. **1** can be included, either alone or in any combination, in any of the other examples of devices, features, components, and parts shown in the other figures described herein. Likewise, any of the features, components, and/or parts, including the arrangements and configurations thereof shown and described with reference to the other figures can be included, either alone or in any combination, in the example of the devices, features, components, and parts shown in FIG. **1**.

[0047] A user having a head **201** of a different size and shape as that of the head **101** shown in FIG. **1** is shown in FIG. **2**. The same or similar head-mountable electronic device **200** can include a viewing frame **202** secured, at least in part, to the user's head **201** via one or more securement arms **204***a*, **204***b*. As show, the securement arms **204***a*, **204***b* can extend distally along opposing sides of the head **201** and include first portions **206***a*, **206***b* and second portions **208***a*, **208***b* removably connected to the first portions **206***a*, **206***b*. In the example shown, the arms **204***a*, **204***b* can extend over the user's ears **203** and toward the rear of the user's head **201**. However, due to the shape of the user's head **201**, the curvature of the arms **204***a*, **204***b* results in a gap **210** between the head **201** and the arms **204***a*, **204***b*.

[0048] In at least one example, the second portions **208***a*, **208***b* of the arms **204***a*, **204***b* can be configured to be disconnected and different second portions **208***a*, **208***b* of a different size and/or shape/curvature (shown in FIG. **2**B) can be reconnected to eliminate the gap **210** and increase the contact area and/or length between the arms **204***a*, **204***b* and the head **201**. The second portions **208***a*, **208***b* of the arms **204***a*, **204***b* can also be reconfigured to hook further around the user's head **201** to more effectively secure the device **200** to the head **201**. As shown in FIG. **2**B, the arms **204***a*, **204***b* include a second portions **208***a*, **208***b*, respectively, that can be fitted to curve with the profile and anatomical features of the user's head **201** as shown.

[0049] Any of the features, components, and/or parts, including the arrangements and configurations thereof shown in FIGS. **2**A and **2**B can be included, either alone or in any combination, in any of the other examples of devices, features, components, and parts shown in the other figures described herein. Likewise, any of the features, components, and/or parts, including the arrangements and configurations thereof shown and described with reference to the other figures can be included, either alone or in any combination, in the example of the devices, features, components, and parts shown in FIGS. **2**A and **2**B.

[0050] FIG. **3** illustrates a side, cross-sectional view of an example of a second portion **308** of a securement arm. As used herein, the term "removable arm" can refer to a removable portion of a securement arm, similar to the second portions **108***a*, **108***b*, **208***a*, **208***b* shown in FIGS. **1**-**2**B. That is, as shown in FIG. **3**, the second portion **308** shown by itself can simply be referred to as a removable securement arm, removable arm, and so forth, indicating that the removable arm **308** shown can be configured to be removably connected to a first portion or non-removable portion of a securement arm connected to the viewing frame of a head-mountable display, such as those shown in FIGS. **1**-**2**B and elsewhere throughout this specification. The first portion to which the removable arm **308** is configured to connect and disconnect can be permanently or fixedly connected to the viewing frame of a device such that the removable arms **308** described herein are removable from the fixed portion of the securement arm.

[0051] However, one or more other examples can also include first portions that are removably connected to the viewing frame or other components of the device. In any case, the removable arms referred to herein are configured to be removably connected to the first portions **106***a*, **106***b*, **206***a*, **206***b* shown in FIGS. **1**-**2**B. In some examples, the removable portions **308** described herein can be configured to be removably connected directly to the viewing frame or other component of a head-mountable device rather than directly to some other portion of a securement arm of the device. In such examples, the removable portion **308** can be configured to be electrically connected to the other portion of the securement arm, either through the viewing frame or some other component of the device.

[0052] In the illustrated example of FIG. **3**, the removable arm **308** of an optical device can include a housing **310** defining an internal volume **312** and an open proximal cavity **314**, an electronic component **316** disposed in the internal volume adjacent to the open proximal cavity **314**, and an electrical connector **318** disposed on the housing **310**. In one example, the electronic component **316** is disposed distal to the open proximal cavity **314**. In at least one example, an opening **315** is defined by a proximal end of the housing **310**, providing access to the open cavity **314** of the internal volume **310**. In at least one example, the electronic component **316** can include one or more batteries and be disposed in a distal portion of the internal volume **312** defined by the housing **310**.

[0053] In addition, at least one example of the removable arm **308** can also include an electrical connector **318** disposed at a proximal end of the housing **310**. The electrical connector can be electrically connected to the electronic component **316** and provide an electrical contact with another portion of a securement arm, or other component of the head-mountable device to which the removable arm **308** can be connected, in order to complete an electrical circuit between the electronic component(s) **316** of the removable arm **308** and any electronic components of the device or other arm portion to which the removable arm **308** is connected. In at least one example, the electrical connector **318** can be disposed at a proximal end of the housing **310**, as shown in FIG. **3**. Other examples can include electrical connectors **318** disposed elsewhere on the housing, including at a distal end or portion of the housing **310** or on an outer or end surface of the housing **310**.

[0054] Any of the features, components, and/or parts, including the arrangements and configurations thereof shown in FIG. **3** can be included, either alone or in any combination, in any of the other examples of devices, features, components, and parts shown in the other figures described herein. Likewise, any of the features, components, and/or parts, including the arrangements and configurations thereof shown and described with reference to the other figures can be included, either alone or in any combination, in the example of the devices, features, components, and parts shown in FIG. **3**.

[0055] FIG. **4** illustrates an example of a head-mountable electronic device **400**, such as a virtual reality or augmented reality optical device. The device **400** can include a viewing frame **402** and a securement arm **404** extending from the viewing frame **402**. In at least one example, the securement arm **404** can include a first portion **406** and a second portion **408** removably connected to the first portion **406**. In the illustrated example, the second portion **408** is positioned generally distally to the first portion **406**. The second portion can include a housing **410** defining an internal volume **412** that has an open cavity **414**. The second portion **408** can also include an electronic component **416** disposed distally to the open cavity **414** in the internal volume **412**, as shown. Disposing the electronic component **416** distally in the second portion **408** can increase weight at the distal end of the device **400** to balance the weight of the display frame **402**, which may include other electronic components, lenses, and displays. This can provide a more balanced and comfortable fit for the user.

[0056] The first portion **406** can include an electrical connector **418***b* that contacts an electrical connector **418***a* of the second portion **408** to complete an electrical circuit from the electronic component **416** to the first portion **406**. One or more circuitry elements, including wires and other electronic connection components can be disposed within the second portion **406**, either on or in the housing **410** or within the internal volume **412**, to electrically connect the electronic component **416** with the electrical connector **418***a*.

[0057] In at least one example, they first portion **406** can at least partially extend into the open cavity **414** of the second portion **408**. The second portion **408** can connect to the first portion **406** at a proximal end of the second portion **408**, as shown, and at least a portion of the first portion **406** can extend into the open cavity **414** of the internal volume **412** of the second portion **408**. The extent to which the first portion **406** extends into the second portion **408** can vary in one or more other examples. The outer perimeter dimension of the part of the first portion **406** extending into the open cavity **414** of the second portion **408** is equal to or less than an inner perimeter dimension of the housing **410** of the second portion **408** defining the open cavity **414** of the internal volume **412**.

[0058] Any of the features, components, and/or parts, including the arrangements and configurations thereof shown in FIG. **4** can be included, either alone or in any combination, in any of the other examples of devices, features, components, and parts shown in the other figures described herein. Likewise, any of the features, components, and/or parts, including the arrangements and configurations thereof shown and described with reference to the other figures can be included, either alone or in any combination, in the example of the devices, features, components, and parts shown in FIG. **4**.

[0059] FIG. **5** illustrates an example of a head-mountable electronic device **500**, such as a virtual reality or augmented reality optical device. The device **500** can include a viewing frame **502** and a securement arm **504** extending from the viewing frame **502**. In at least one example, the securement arm **504** can include a first portion **506** and a second portion **508** removably connected to the first portion **506**. In the illustrated example, the second portion **508** is positioned generally distally to the first portion **506**. The second portion can include a housing **510** defining an internal volume **512** that has an open cavity **514**. The second portion **508** can also include an electronic component **516** disposed distally to the open cavity **514** in the internal volume **512**, as shown.

[0060] The first portion **506** can include an electrical connector **518***b* that contacts an electrical connector **518***a* of the second portion **508** to complete an electrical circuit from the electronic component **516** to the first portion **506**. One or more circuitry elements **522**, including wires and other electronic connection components can be disposed within the second portion **506**, either on or in the housing **510** or within the internal volume **512**, to electrically connect the electronic component **516** with the electrical connector **518***a*.

[0061] In at least one example, they first portion **506** can at least partially extend into the open cavity **514** of the second portion **508**. The second portion **508** can connect to the first portion **506** at a proximal end of the second portion **508**, as shown, and at least a portion of the first portion **506** can extend into the open cavity **514** of the internal volume **512** of the second portion **508**. In at least one example, the second portion **508** can including a latching mechanism that removably secures the second portion **508** to the first portion **506**. In at least one example, the first portion **506** can include the latching mechanism or the latching mechanism can be included on both the first and second portions **506**, **508**. For example, as shown in FIG. **5**, one example of a latching mechanism can include a detent mechanism, including a protrusion **524** of the second portion **508** inserted into and held together by friction with a complimentary channel **526** of the first portion **506**. Other latching mechanisms, including magnetic mechanisms, button mechanisms, and so forth can also be included.

[0062] The extent to which the first portion **506** extends into the second portion **508** can vary in one or more other examples. The outer perimeter dimension of the part of the first portion **506** extending into the open cavity **514** of the second portion **508** is equal to or less than an inner perimeter

dimension of the housing **510** of the second portion **508** defining the open cavity **514** of the internal volume **512**.

[0063] In at least one example, as shown in FIG. **5**, the smaller dimension of the first portion **506** and the larger dimension of the second portion **508** noted above can form a gap **507** between the first portion **506** disposed within the open cavity **514** of the second portion **508**. In this way, the first portion can be free-floating in the open cavity **514**. The term "free-floating," and other similar terms used herein, can refer to a state of being uncontacted by surrounding components and surfaces. Some portions, lengths, or parts of the first portion **506** can be in contact with or connected to the second portion **508**, as shown at the proximal end of the second portion **508** in FIG. **5**, while another portion, length, or part of the first portion **506** can be free-floating within the open cavity **514** of the second portion **508**, as shown.

[0064] In addition, in at least one example, the second portion **508** of a securement arm for a head-mountable display, such as a head-mountable optical device **500**, can disposed at an angle relative to the first portion **506**. In some examples, a distal end or segment **528** of the second portion **508** can be curved, as shown in FIG. **5**, to extend distally and downward behind a user's ear during use.

[0065] Any of the features, components, and/or parts, including the arrangements and configurations thereof shown in FIG. **5** can be included, either alone or in any combination, in any of the other examples of devices, features, components, and parts shown in the other figures described herein. Likewise, any of the features, components, and/or parts, including the arrangements and configurations thereof shown and described with reference to the other figures can be included, either alone or in any combination, in the example of the devices, features, components, and parts shown in FIG. **5**.

[0066] FIG. **6** illustrates an example of a head-mountable electronic device **600**, such as a virtual reality or augmented reality optical device. The device **600** can include a viewing frame **602** and a securement arm **604** extending from the viewing frame **602**. In at least one example, the securement arm **604** can include a first portion **606** and a second portion **608** removably connected to the first portion **606**. In the illustrated example, the second portion **608** is positioned generally distally to the first portion **606**. The second portion can include a housing **610** defining an internal volume **612** that has an open cavity **614**. The second portion **608** can also include an electronic component **616** disposed distally to the open cavity **614** in the internal volume **612**, as shown.

[0067] The first portion **606** and the second portion can include electrical connectors, as shown in other figures, which contact each other at **618** shown in FIG. **6**. The electrical connector **618** can complete an electrical circuit from the electronic component **616** to the first portion **606**. One or more circuitry elements, including wires and other electronic connection components can be disposed within the second portion **606**, either on or in the housing **610** or within the internal volume **612**, to electrically connect the electronic component **616** with the electrical connector **618**.

[0068] In at least one example, they first portion **606** can at least partially extend into the open cavity **614** of the second portion **608**. The second portion **608** can connect to the first portion **606** at a proximal end of the second portion **608**, as shown, and at least a portion of the first portion **606** can extend into the open cavity **614** of the internal volume **612** of the second portion **608**. The extent to which the first portion **606** extends into the second portion **608** can vary in one or more other examples. The outer perimeter dimension of the part of the first portion **606** extending into the open cavity **614** of the second portion **608** is equal to or less than an inner perimeter dimension of the housing **610** of the second portion **608** defining the open cavity **614** of the internal volume **612**.

[0069] In addition, in at least one example, the first portion **606** can include a housing **630** defining an internal volume **632** and an electronic component **636** disposed within the internal volume **632**. The electronic component **636** can be connected to the electronic component **616** of the second portion **608** through various circuitry components and electronic connections **618** discussed elsewhere herein. In at least on example, the electronic component **636** disposed in the first portion **606** can include a speaker and the circuitry components can include wires and circuit boards, or any other electronic components used in the head-mountable device to deliver augmented or virtual reality visuals, sounds, and other outputs. The housing **632** of the first portion **606** can define a first aperture **634** and the speaker **636** can be disposed, oriented, or otherwise configured to direct an output, such as sound waves and vibrations, through the first aperture **634**. The electronic component **636**, or speaker **636**, can be positioned to fluidly communicate with an external environment through the first aperture **634**.

[0070] In addition, in at least one example, the housing **610** of the second portion **608** can define a second aperture **638** through which the output of the speaker **636** can be directed through the housing **610** of the second portion **608**. The second aperture **638** can be disposed distally to the proximal opening or end of the second portion **608**. In at least one example, as shown in FIG. **6**, the first and second apertures **634**, **638** can be aligned, as shown in FIG. **6**. However, other examples of securement arms can include first and second apertures **634**, **638** are misaligned such that one or the other is positioned more proximally or more distally than the other relative to the viewing frame **602**. The quality of the output of the electronic device **636** disposed within the first portion **606**, for example the quality of sound output from a speaker, from the user's perspective, can be based, at least in part, on the position of the second aperture **638**, through which sound exits the securement arm **604**.

[0071] This may be the case, for example, if a user having an car position different than another user connects a second portion **608** of the securement arm **604** with an aperture positioned for his or her car, which may be different than the position of another user's ear. The position of the second aperture **638** can be customized or chosen based on the position of a specific user's ear relative to their nose such that a second portion **608** having a position of the second aperture **638** relative to the viewing frame **602**, which rests on the user's nose, is optimal for that user. Before using or purchasing a device, a user can determine the critical anatomical measurements and purchase or use a swappable, removable second portion **608** based on those measurements.

[0072] Any of the features, components, and/or parts, including the arrangements and configurations thereof shown in FIG. **6** can be included, either alone or in any combination, in any of the other examples of devices, features, components, and parts shown in the other figures described herein. Likewise, any of the features, components,

and/or parts, including the arrangements and configurations thereof shown and described with reference to the other figures can be included, either alone or in any combination, in the example of the devices, features, components, and parts shown in FIG. **6**.

[0073] FIG. **7** shows a partial, cross-sectional view of another example of a securement arm **704**, including a first portion **706** disposed within an open cavity **714** of an internal volume **712** defined by a housing **710** of a second portion **708**. The first portion **706** can include a housing **730** defining an internal volume **732** in which a speaker **736** or other electronic component is disposed. The housing **730** of the first portion **706** can define a first aperture **734** and the housing **710** of the second portion **708** can define a second aperture **738**, through which the speaker **736** can direct a sound output. In examples where a gap is formed between the housing **730** of the first portion **706** and the housing **710** of the second portion **708**, as shown in FIG. **7**, one or more output barriers **740***a*, **740***b* can be disposed between the housing **710** of the second portion **708** and the housing **730** of the first portion **706**. The output barriers **740***a*, **740***b* can closed off an output path between the first and second apertures **734**, **738** to prevent or minimize sound traveling elsewhere within the inner volume **712** of the second portion **708** after passing through the first aperture **734**.

[0074] Any of the features, components, and/or parts, including the arrangements and configurations thereof shown in FIG. **7** can be included, either alone or in any combination, in any of the other examples of devices, features, components, and parts shown in the other figures described herein. Likewise, any of the features, components, and/or parts, including the arrangements and configurations thereof shown and described with reference to the other figures can be included, either alone or in any combination, in the example of the devices, features, components, and parts shown in FIG. **7**.

[0075] FIG. **8** illustrates an example of a head-mountable electronic device **800**, such as a virtual reality or augmented reality optical device. The device **800** can include a viewing frame **802** and a securement arm **804** extending from the viewing frame **802**. In at least one example, the securement arm **804** can include a first portion **806** and a second portion **808** removably connected to the first portion **806**. In the illustrated example, the second portion **808** is positioned generally distally to the first portion **806**. The second portion can include a housing **810** defining an internal volume **812** that has an open cavity **814**. The second portion **808** can also include an electronic component **816** disposed distally to the open cavity **814** in the internal volume **812**, as shown.

[0076] The first portion **806** and the second portion can include electrical connectors, as shown in other figures, which contact each other at **818** shown in FIG. **8**. The electrical connector **818** can complete an electrical circuit from the electronic component **816** to the first portion **806**. One or more circuitry elements, including wires and other electronic connection components can be disposed within the second portion **806**, either on or in the housing **810** or within the internal volume **812**, to electrically connect the electronic component **816** with the electrical connector **818**.

[0077] In at least one example, they first portion **806** can at least partially extend into the open cavity **814** of the second portion **808**. The second portion **808** can connect to the first portion **806** at a proximal end of the second portion **808**, as shown, and at least a portion of the first portion **806** can extend into the open cavity **814** of the internal volume **812** of the second portion **808**. The extent to which the first portion **806** extends into the second portion **808** can vary in one or more other examples. The outer perimeter dimension of the part of the first portion **806** extending into the open cavity **814** of the second portion **808** is equal to or less than an inner perimeter dimension of the housing **810** of the second portion **808** defining the open cavity **814** of the internal volume **812**.

[0078] In addition, in at least one example, the first portion **806** can include a housing **830** defining an internal volume **832** and an electronic component **836** disposed within the internal volume **832**. The electronic component **836** can be connected to the electronic component **816** of the second portion **808** through various circuitry components and electronic connections **818** discussed elsewhere herein. In at least on example, the electronic component **836** disposed in the first portion **806** can include a speaker. The housing **832** of the first portion **806** can define a first aperture **834** and the speaker **836** can be disposed, oriented, or otherwise configured to direct an output, such as sound waves and vibrations, through the first aperture **834**.

[0079] In addition, in at least one example, the housing **810** of the second portion **808** can define a second aperture **838** through which the output of the speaker **836** can be directed through the housing **810** of the second portion **808**. The second aperture **838** can be disposed distally to the proximal opening or end of the second portion **808**. In at least one example, as shown in FIG. **8**, the first and second apertures **834**, **838** can be aligned, as shown in FIG. **8**. In the example shown in FIG. **8**, the second aperture **838** is disposed distally to the first aperture **834**. This position of the second aperture **838** can accommodate a user's specific ear position to optimize the location of sound output by the speaker **836** and through the first and second apertures **834**, **838** of the securement arm **804**.

[0080] Any of the features, components, and/or parts, including the arrangements and configurations thereof shown in FIG. **8** can be included, either alone or in any combination, in any of the other examples of devices, features, components, and parts shown in the other figures described herein. Likewise, any of the features, components, and/or parts, including the arrangements and configurations thereof shown and described with reference to the other figures can be included, either alone or in any combination, in the example of the devices, features, components, and parts shown in FIG. **8**.

[0081] FIG. **9** shows a partial, cross-sectional view of another example of a securement arm **904**, including a first portion **906** disposed within an open cavity **914** of an internal volume **912** defined by a housing **910** of a second portion **908**. The first portion **906** can include a housing **930** defining an internal volume **932** in which a speaker **936** or other electronic component is disposed. The housing **930** of the first portion **906** can define a first aperture **934** and the housing **910** of the second portion **908** can define a second aperture **938**, through which the speaker **936** can direct a sound output. In examples where a gap is formed between the housing **930** of the first portion **906** and the housing **910** of the second portion **908**, as shown in FIG. **9**, one or more output barriers **940***a*, **940***b* can be disposed between the housing **910** of the second portion **908** and the housing **930** of the first portion **906**. The output barriers **940***a*, **940***b* can closed off an output path between the first and second

apertures **934**, **938** to prevent or minimize sound traveling elsewhere within the inner volume **912** of the second portion **908** after passing through the first aperture **934**.

[0082] Any of the features, components, and/or parts, including the arrangements and configurations thereof shown in FIG. **9** can be included, either alone or in any combination, in any of the other examples of devices, features, components, and parts shown in the other figures described herein. Likewise, any of the features, components, and/or parts, including the arrangements and configurations thereof shown and described with reference to the other figures can be included, either alone or in any combination, in the example of the devices, features, components, and parts shown in FIG. **9**.

[0083] FIGS. **10**A and **10**B show a partial, cross-sectional view and a cross-sectional view, respectively of another example a securement arm **1004**, including a first portion **1006** disposed within an internal volume **1012** defined by a housing **1010** of a second portion **1008**. The first portion **1006** can include a housing **1030** defining an internal volume **1032** with an electronic component **1036** disposed within the internal volume **1032**. In at least one example, the electronic component **1036** can include a speaker that includes a speaker diaphragm **1042** and a speaker magnet **1026** configured to actuate the diaphragm **1042**.

[0084] In addition, in at least one example, the removable second portion **1008** of the securement arm **1004** can include a latching mechanism **1024** that is disposed next to, adjacent with, or aligned by the speaker magnet **1026** of the speaker **1036**. In one example, the latching mechanism **1024** can include a latching magnet **1024**. The latching magnet **1024** can be disposed on or in the housing **1010** or internal volume **1012** of the second portion **1008** such that an attraction between the latching magnet **1024** and the speaker magnet **1026** maintains the second portion **1008** in position relative to the first portion **1006**. The attractive force between the two magnets **1024**, **1026** can be overcome by the user to separate the first and second portion **1006**, **1008** of the removable securement arm **1004** when disconnecting the second portion **1008** from the first portion **1006**.

[0085] In addition, in at least one example, the latching magnet **1024** can combine with the speaker magnet **1026** to actuate the speaker diaphragm **1042** along with the speaker magnet **1026**. In the cross-sectional view of FIG. **10**B, another example is shown of the latching magnet **1024** aligned with, above, or next to the speaker magnet **1026** actuating the speaker diaphragm **1042**. In the illustrated example, the speaker **1036** can be held in place within the first portion **1006** via a bracket **1044** and one or more conductive members, including a first conductive member **1046** of the first portion **1006** and a second conductive member **1048** of the second portion **1008**, can be disposed and configured to direct a magnetic field **1050**, illustrated by directional field arrows, such that the magnetic field **1050** flows through the combined speaker magnet **1026** and latching magnet **1024** to actuate the speaker diaphragm **1024**. In this way, the latching magnet can serve a dual purposed of removably connecting the second portion **1008** to the first portion **1006** of the securement arm **1004** and actuating the speaker **1036** in the first portion **1006**. As a result, the size of the speaker magnet **1026** disposed in the first portion **1006** can be reduced while maintaining speaker performance with the combine magnet configuration shown.

[0086] Any of the features, components, and/or parts, including the arrangements and configurations thereof shown in FIGS. **10**A and **10**B can be included, either alone or in any combination, in any of the other examples of devices, features, components, and parts shown in the other figures described herein. Likewise, any of the features, components, and/or parts, including the arrangements and configurations thereof shown and described with reference to the other figures can be included, either alone or in any combination, in the example of the devices, features, components, and parts shown in FIGS. **10**A and **10**B.

[0087] Physical environments include tangible elements that can be interacted with without the use of electronic devices. For instance, a physical environment may correspond to a physical city having physical buildings, roads, and vehicles. People may directly sense or interact with a physical environment through any number of senses such as smell, sight, taste, hearing, and touch. In contrast, an extended reality (XR) environment may refer to a partially or wholly simulated environment that people may sense or interact with using an electronic device. The XR environment may include virtual reality (VR) content, mixed reality (MR) content, augmented reality (AR) content, or the like. Using an XR system, a portion of a person's physical motions, or representations thereof, may be tracked and, in response, properties of virtual objects in the XR environment may be changed in a way that complies with at least one law of nature. For example, the XR system may detect a user's head movement and adjust auditory and graphical content presented to the user in a way that simulates how sounds and views would change in a physical environment. In other examples, the XR system may detect movement of an electronic device (e.g., a laptop, tablet, mobile phone, or the like) presenting the XR environment. Accordingly, the XR system may adjust auditory and graphical content presented to the user in a way that simulates how sounds and views would change in a physical environment. In some instances, other inputs, such as a representation of physical motion (e.g., a voice command), may cause the XR system to adjust properties of graphical content.

[0088] Numerous types of electronic systems may allow a user to sense or interact with an XR environment. A non-exhaustive list of examples includes lenses having integrated display capability to be placed on a user's eyes (e.g., contact lenses), heads-up displays (HUDs), projection-based systems, head mountable systems, windows or windshields having integrated display technology, headphones/earphones, input systems with or without haptic feedback (e.g., handheld or wearable controllers), smartphones, tablets, desktop/laptop computers, and speaker arrays. Head mountable systems may include an opaque display and one or more speakers. Other head mountable systems may be configured to receive an opaque external display, such as that of a smartphone. Head mountable systems may capture images/video of the physical environment using one or more image sensors or capture audio of the physical environment using one or more microphones. Instead of an opaque display, some head mountable systems may include a transparent or translucent display. Transparent or translucent displays may direct light representative of images to a user's eyes through a medium, such as a hologram medium, optical waveguide, an optical combiner, optical reflector, other similar technologies, or combinations thereof. Various display technologies, such as liquid crystal on silicon, LEDs, uLEDs, OLEDs,

laser scanning light source, digital light projection, or combinations thereof, may be used. In some examples, the transparent or translucent display may be selectively controlled to become opaque. Projection-based systems may utilize retinal projection technology that projects images onto a user's retina or may project virtual content into the physical environment, such as onto a physical surface or as a hologram.

[0089] Personal information data, collected according to authorized and well established secure privacy policies and practices that are appropriate for the type of data collected, can be used to implement and improve on the various concepts described herein. The disclosed technology is not, however, rendered inoperable in the absence of such personal information data.

[0090] It will be understood that the details of the present systems and methods above can be utilized in various combinations and with alternative components. The scope of the present systems and methods will be further understood by the following claims.

What is claimed is:

1. A removable securement arm of an optical device, comprising:

a housing defining an internal volume including an open proximal cavity;

an electronic component disposed in the internal volume adjacent to the open proximal cavity; and

an electrical connector disposed on the housing.

2. The removable securement arm of claim **1**, wherein the electronic component comprises a battery.

3. The removable securement arm of claim **1**, wherein the electronic component is disposed in a distal portion defined by the housing.

4. The removable securement arm of claim **1**, wherein the electrical connector is disposed at a proximal end of the housing.

5. The removable securement arm of claim **1**, further comprising a circuitry component connecting the electrical connector to the electronic component.

6. The removable securement arm of claim **1**, wherein a proximal end of the removable securement arm defines an opening.

7. The removable securement arm of claim **6**, wherein the housing defines an aperture distal to the opening.

8. A securement arm of an optical device, comprising:

a first portion including:

a first housing defining a first internal volume and a first aperture; and

an electronic component disposed in the internal volume and positioned to fluidly communicate with an external environment through the first aperture; and

a second portion removably connected to the first portion, the second portion comprising:

a second housing defining a second internal volume and a second aperture; and

a securement mechanism;

wherein the second housing is sized to receive the first housing into the second internal volume.

9. The securement arm of claim **8**, wherein the securement mechanism comprises a magnet.

10. The securement arm of claim **9**, wherein the electronic component comprises a speaker.

11. The securement arm of claim **10**, wherein the magnet actuates the speaker.

12. The securement arm of claim **10**, wherein the speaker directs sound out of the second aperture.

13. The securement arm of claim **8**, wherein a gap is formed between an external surface of the first housing and an internal surface of the second housing when the second housing receives the first housing.

14. A head mountable display, comprising:

a viewing frame;

a first arm portion extending from the viewing frame, the first arm portion having a first housing extending from a proximal end to a distal end; and

a second arm portion removably secured to the first arm portion, the second arm portion comprising a second housing defining a second internal volume including an open cavity;

wherein the second arm portion contacts the first arm portion at the proximal end and the first housing is free-floating in the open cavity.

15. The head-mountable display of claim **14**, wherein the first housing defines a first internal volume and a first electronic component is disposed in the first internal volume.

16. The head-mountable display of claim **15**, further comprising a second electronic component disposed in the second internal volume.

17. The head-mountable display of claim **17**, wherein the second electronic component comprises a battery.

18. The head-mountable display of claim **15**, wherein the first electronic component comprises a speaker.

19. The head-mountable display of claim **18**, wherein the second arm portion comprises a magnet.

20. The head-mountable display of claim **19**, wherein the magnet actuates the speaker.

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